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TEA RESEARCH INSTITUTE

OF CEYLON

THE TEA RESEARCH INSTITUTE,
St. Coombs, Talawakelle,
Ceylon.

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THE MIXTURE AS PRESCRIBED

J. Lamb and J. A. H. Tolhurst

This article is frankly popular in style, and is meant to convey broad principles only. The intention is to discuss the wider aspects of manuring and plant nutrition and, since so little, relatively speaking, is known about the subject, it is of necessity highly speculative. Much nonsense has been written about ' artificial ' or ' chemical' fertilisers, about their poisonous action on the soil, on human beings and animals fed on crops grown with their aid, about the destruction of earth-worms and organic matter. We propose, therefore, to give an unprejudiced view of this infinitely complex subject, and, as a demonstration of good faith, we will admit that artificial or chemical manures, which we prefer to call mineral manures, are capable through misuse of causing harmful effects upon soil and that accusations of an ' N.P.K. ' mentality amongst some modern agriculturists are not wholly unjustified. Most agricultural malpractices are, however, due to ignorance or indifference, and the blame should be placed fairly and squarely upon the users of mineral fertilisers and not on the materials.

An ' N.P.K. ' mentality infers preoccupation with the three nutrients nitrogen, phosphate and potash. For every 1,000 pounds made tea removed per acre per annum the permanent loss (crop and prunings) of these three nutrients is approximately as follows :—

Nitrogen	...	64 lb.
Phosphate (P_2O_5)	...	16 lb.
Potash (K_2O)	...	35 lb.

In all manurial calculations the common practice is to refer only to nitrogen, P_2O_5, and K_2O. If TRI-500 is used as recommended by the Tea Research Institute the following quantities of N.P.K. will be returned to the soil following the removal of 1,000 pounds of crop :—

Nitrogen	...	80 lb.
Phosphate (P_2O_5)	...	39 lb.
Potash (K_2O)	...	47 lb.

This appears to be generous treatment and, as a matter of fact it is, but the N.P.K. figures reveal only a part of the balance between removal and replacement.

Calcium (lime) and magnesium also are essential for plant growth. There is every reason to believe that in tea there is a very close relationship between these two elements and potassium. In any case, magnesium is part of the ' life blood ' of plants, an essential constituent of chlorophyll and the parallel of iron in haemoglobin of animal blood. It is estimated that some 50 lb. of calcium and magnesium are removed by a 1,000 lb. crop. It is possible, therefore, that our acid soils are

low in calcium and magnesium ; certainly their drainage waters have been shown to contain only one hundredth as much of these two nutrients as normal drainage from temperate regions. We suggest, therefore that the calcium and magnesium reserves are much less than the nitrogen reserves, which are remarkably high in Ceylon tea soils. For example, St. Coombs No. 1 field contains 0.27 per cent. of nitrogen in the top 6 inches, and 0.24 per cent. in the next 6 inches, amounting to some 10,000 lb. per acre in the top foot, equivalent to 50,000 lb. of sulphate of ammonia. And yet, because so much of this nitrogen reserve is locked up in a form unavailable to the tea bush at sufficient rate, we have to add more nitrogen to maintain an economic crop return. Surely, therefore, there is all the more reason for supplying calcium and magnesium to offset the dwindling reserves of these two nutrients.

How much calcium and magnesium are we in fact returning to the soil ? Many planters would probably answer ' none ', adding something to the effect that liming tea soils was abandoned years ago. In actual fact we do add considerable quantities, because saphosphosphate is principally calcium phosphate (phosphate of lime) and with the 39 lb. of phosphate (P_2O_5) we are in fact adding 60 lb. of lime (CaO), up to 12 lb. of which may be in the form of chalk (calcium carbonate). The saphosphosphate will in addition supply 1.84 lb. of magnesia (MgO). Muriate of potash also contains some magnesium and 47 lb. will contribute about half a pound of magnesia (MgO) in a highly soluble form.

When the magnesium content of plants is on the border-line of minimum essential requirements high potash manuring may depress the magnesium content still further, and induce a magnesium deficiency. This illustrates very well the complexities which must be taken into account in manuring.

Sulphur is another element which is essential to the growth of plants, and is apparently of particular importance to tea. One of the first clearly recognised widespread deficiency diseases occurred in tea in Nyasaland. The disease known as tea yellows was cured by sulphur in the form of sulphate of ammonia, and since our manurial mixtures contain liberal amounts of this ingredient there is no cause for any further discussion of this element.

Iron and manganese are essential nutrients, and we have no fear for the supply of iron from tea soils, the content being virtually inexhaustible. Saphosphosphate returns a large proportion of the manganese removed by the crop.

With regard to trace elements such as copper and zinc the tea bush, judging from analysis, requires such large quantities that they are worth special consideration. The fact that tea leaves contain such large amounts of copper and zinc does not necessarily mean that these amounts are essential for growth ; this is one of the great difficulties in the study of plant nutrition. Plants do not normally excrete minerals, and may accumulate them apparently quite unnecessarily. However, copper is known to be essential for fermentation, as it was clearly proved at the Tea Research Institute some years ago that the principal enzyme (ferment) responsible for fermentation is a copper protein compound. Ceylon exports the equivalent of over 3 tons of copper metal every year in tea and a rather larger quantity of zinc. Although it is possible that the supplies of copper and zinc in the soil are sufficient the continuous and, at present, increasing cropping of tea land make it desirable to consider whether the supplies of these materials are in fact adequate. Saphosphosphate contains 0.013 per cent. of copper and 0.02 per cent. of zinc which means that both elements are practically fully replaced, or at least supplement the soil supplies to a very generous extent. The copper supplies are, of course, most adequately ensured where copper fungicides are employed to control blister blight.

The general conclusion is, therefore, that TRI-500, applied at the recommended rates is an adequate general nutrient mixture, and not merely an N.P.K. mixture. From time to time suggestions are made that trace elements should be incorporated

in the mixture, but we cannot support this idea. Both saphosphosphate and muriate of potash contain other trace elements and field experiments have so far failed to show any response to further additions of the most important trace elements.

Nothing is further from our intention than to suggest that TRI-500 is the last word in manurial mixtures for Ceylon tea. It is frankly nothing more than a compromise, but it at least has a quarter of a century of quite intensive research behind it, and is based on facts and considerations which are far more complicated than is generally realised. We have mentioned only a few of the many intricate considerations behind a seemingly simple N.P.K. mixture.

It is also perhaps as well to counter the idea that the chemical analysis of plants can always give a reliable guide to field requirements. As already pointed out many of the minerals in a plant may be present in amounts far in excess of the requirements for normal growth ; they may be in excess to the extent of slowing down growth or being actively toxic. Also the amounts of minerals in the plant at harvest time give little idea of the amounts which should be applied in manure for optimum crop levels. For instance turnips usually need large applications of phosphate to ensure a good crop, but the amount of phosphate in the turnip, when pulled, is very low. Some manures have a very low efficiency in certain soils ; soluble phosphates, for example, are quickly converted to relatively insoluble forms in alkaline soils, and also in acid soils containing reactive iron and aluminium, at least after periods of drought. Nitrates are very rapidly washed out of soil by heavy rain.

Nevertheless, plant analysis will, if systematically employed, give information about the minimum amounts of nutrients required by any particular crop, and if the nutrients are not present in available form in the soil, they must be supplied as fertilisers. The relation between the amount of fertiliser and yield can only be worked out by accurate field experiments. So far, chemical analysis of plant material and field experiments have been employed in gaining information on which to formulate manure mixtures for tea. This is not the end of the story by any means. Present and future research on the manuring of tea must be carried out by co-ordinating plant and soil analysis with field experiments, which brings us back to the subject of calcium and magnesium status of soils. Coupled with this, is the subject of possible harmful effects of sulphate of ammonia when applied to soils over long periods.

Before the difficulties and dangers we have in mind can be understood, it is necessary to explain what happens when sulphate of ammonia is added to a soil containing clay and organic matter. If it were added to pure sand it would wash straight through. Sulphate of ammonia is highly soluble in water and a few showers of rain would wash it beyond the reach of any plants which could survive in pure sand. Clay and organic matter have a capacity for holding certain nutrients called base exchange capacity. This is a definite physical property and can be measured. It is quite easy to understand if a simple parallel of fabrics and dyes is taken. Some fabrics stain very easily and strains are very difficult to remove. These fabrics have, according to this parallel, a high base exchange capacity. Other fabrics do not stain so easily and stains are easily washed out—these have a low base exchange capacity. The dyes in different fruit juices also vary in the way they will stain any one fabric, and in the same way different nutrients such as ammonia, potassium, calcium, etc. vary in the strength by which they stain different clays.

When sulphate of ammonia, dissolved in rain or soil moisture, comes into contact with clay and organic matter, the ammonia is held by this physical force, (base exchange capacity), which also holds other bases such as potassium, calcium, magnesium, iron, aluminium and so on. The sulphate combines with another base, usually calcium, which is washed out of the soil in drainage water. Some of the sulphate is, of course, used by the plant in which case the amount of loss is reduced.

Every addition of sulphate of ammonia is, therefore, possibly depleting the reserves of calcium in the soil. This is certainly the case in the temperate soils which have been most closely investigated. In the acid soils on which tea is grown the mechanism may be rather different and the drain on calcium less, but it needs investigation. Work is in progress both in Ceylon and North East India.

Recent research at St. Coombs has indicated that the tea bush, almost certainly, is not able to take up its nitrogen directly as ammonia, but that the ammonia held by the clay has to be nitrified by soil bacteria and converted to nitrate. The nitrates usually again combine with calcium to form calcium nitrate and, since nitrates are not held by base exchange, they are easily washed out of the soil and thus may lead to further losses of calcium. In countries such as England and America, where soil research has been far more intensive than it has been in tropical areas, these losses of calcium have been closely investigated. It is estimated that the addition of each 100 pounds of sulphate of ammonia causes the loss of between 100 and 120 pounds of calcium carbonate under field conditions. Expressed as lime (CaO, the unit used earlier in the article), this means that the 400 lb. of sulphate of ammonia applied in TRI-500 for each 1,000 pounds of crop causes the loss of 225 pounds of lime (CaO).

As already explained, the lime added as calcium phosphate, (Saphos), only little more than compensates for that removed by the crop. Since our tea soils are of low lime status, (tea will not grow in calcareous soils, i.e. soils of high lime status), prudence suggests that the whole question of lime status should be investigated. Soil research, like medical research, should be primarily designed to keep the patient healthy rather than to discover the causes of the diseases. There is no cuase for immediate alarm, since, although the calcium content of our soils may be low, there are one million pounds of soil per acre in each 3 inch layer, and if the tea bush feeds in only the top two feet of soil it has 8,000,000 pounds of soil from which to draw its nutrients. In most areas there is also much undecomposed, and partly decomposed rock which supplies nutrients as it weathers. There is very little information about the composition of parent rock in the tea areas. Table 1 is compiled from a paper on the Geology of Ceylon.

Table 1. *Rock analyses (Adams).*

Rock	Site	PERCENTAGE				
		CaO	MgO	K_2O	P_2O_5	Al_2O_3
Charnockite	Nuwara Eliya	3.4	1.4	3.4	0.8	12.5
,,	Hatton	4.5	2.3	1.3	0.6	11.2
,,	Bulutota	2.0	0.4	5.3	0.1	11.7
Norite type	nr. Pussellawa	3.4	0.6	2.2	0.2	11.1
Diorite type	Nuwara Eliya	8.3	2.0	1.1	0.2	18.7

There is still less information about partly decomposed rock, but Mr. Ramaswamy of the Chemical Division has analysed a few samples recently to give some idea of the position. Rotten rock is a familiar sight to all who live and work on tea estates, and the description of reddish brown, and black rotten rock is adequate. Sample No. 3 was a deposit rather than ordinary rotten rock, but similar material can frequently be seen in fresh road cuttings.

Table 2

	Sample 1	Sample 2	Sample 3
Colour	Reddish brown	Black	Black
Loss on ignition	28.97%	12.20%	—
Moisture	—	—	3.40
Silica (SiO_2)	3.01	3.69	66.76
Aluminium (Al_2O_3)	8.60	1.35	14.72
Iron (Fe_2O_3)	58.25	81.15	2.13
Calcium (CaO)	0.02	0.01	0.44
Magnesium (MgO)	nil	nil	1.03
Manganese (MnO_2)	nil	0.02	8.43
	98.85	98.42	96.91

The rocks from which our soils are derived are of an acidic nature and the weathering processes tend to remove bases such as calcium, magnesium and potassium.

If we continue to use sulphate of ammonia we may have to consider the use of ground limestone in addition to TRI-500. The dolomitic limestone available in Ceylon also contains considerable quantities of magnesium which is a probable advantage. However, the quantity used must not affect the acidity of the soil and needs careful investigation. We do not advise estates to attempt application of limestone until further information is available. It may not even be necessary.

Urea as an alternative to sulphate of ammonia is a possible future development especially as we understand that the production of urea has certain technical advantages over the production of sulphate of ammonia. Urea does not cause the same drain on calcium in the soil, but, even if it should prove satisfactory as a source of nitrogen for tea, prudence suggests the use of some source of sulphur with it. Although there is no urgent need for changes in the practice of manuring there is urgent need for intensified research.

Sulphate of ammonia is subject to some quite ridiculous accusations. One is that it poisons earthworms. The truth of the matter is that earthworms do not thrive on acid soils and are not found in the virgin jungle or patna which preceded tea, except in litter or the less acid mulches which occasionally form on the jungle floor. They are only very rarely found in our soils and play no great part in forming humus. In fact animals and insects appear to have little to do with the breakdown of organic matter in tea soils, or in the parent jungle or patna. So far as is known at present the organic matter in our soils is formed mainly by fungi, and is of a different nature to the humus formed by the aid of earthworms. This is by no means peculiar to Ceylon. The type of humus found on the forest floor in Ceylon, where the soil is acid and low in calcium, corresponds approximately to *MOR*. Mor formation occurs on the surface of the forest floor as distinct from *MULL*, where the litter is rapidly incorporated in the soil by a variety of creatures including earthworms. Mull is commonly known as ' Leaf mould ' and is highly prized by enthusiastic gardeners. The term Mull or Mor can perhaps only be legitimately applied to temperate conditions, but the breakdown of organic matter in Ceylon tea areas, both up-country and the low-country, resembles Mor formation.

The notion that sulphate of ammonia burns away organic matter in the soil is also without foundation. The amount of organic matter in tea soils, where sulphate of ammonia mixtures have been used continuously for many years, remains at a very high level and there are indications of an actual increase in patna soils[1]

1. Eden, T.-Monographs on Tea Production in Ceylon, No. 1, p. 51.

where the level of organic matter is initially very high. The oldest field on St. Coombs Estate, originally opened from jungle, contains 5 to 6 per cent. of organic matter in the top six inches of soil, 4 to 5 per cent. in the next six inches, gradually diminishing to 2 per cent. at 60 inches. The organic matter in virgin jungle soil alongside, is almost exactly similar in amount. How the organic matter is carried down in the soil is at present a mystery. Attempt have been made to count the various moving creatures in the jungle soil ; total numbers are low even in the surface soil, and practically none were found deeper than a few inches. As explained in the earlier reference to Mor formation, decomposition takes place on the surface of the soil and it must be assumed that the decomposed organic matter moves down through the agency of water movement and micro-organisms.

The organic matter in well managed low-country soils is also surprisingly high and over 5 per cent. has been found in soils that have been under tea for 30 years. Organic matter is more easily lost in the low-country, but there is no evidence that this is specifically due to the use of sulphate of ammonia. Lack of a good cover of tea, due to inadequate manuring, can lead to destruction of organic matter in the exposed soil, more particularly in the low-country. A normal tea soil which has been under tea for half a century may contain over 100,000 pounds of organic matter per acre in the top six inches. This illustrates the futility of using slaughter house waste products (commonly called ' Organics ') at least from the point of view of their alleged humus forming properties.

It is possible that the large amount of organic matter found in our tea soils is due to slow breakdown under acid soil conditions. Sulphate of ammonia may, by contributing ammonia supplies to soil organisms, particularly fungi, actually add to the formation of organic matter.

Apart from large amounts of organic matter, as already mentioned, our soils contain a surprisingly large amount of nitrogen (viz. 10,000 pounds per acre in the top foot of St. Coombs No. 1 field). The amount of ammonia held by base exchange capacity is very high although several other investigations on tropical soils have revealed a similar state of affairs. Nitrifying bacteria require a good supply of calcium and phosphate, (as well as adequate amounts of iron, copper and zinc), for their activities, and their action tends to slow down under acid conditions. It is, therefore, possible that low calcium status in our soils may hinder the activities of nitrifying organisms and account for the comparatively large amounts of available ammonia, even to the point of limiting the rate at which nitrate is available to the tea bush. An investigation of the rate of nitrification in our soils is at present in progress.

As a final note of warning, however, against indiscriminate use of lime on tea soils, it must be pointed out that nitrates are readily washed out of soil and that excessive nitrification would lead to heavy losses of nitrogen. Excessive nitrification might even begin to oxidise away the organic matter in our soils, and since organic matter is at least as important, perhaps even more important, than clay in so far as base exchange capacity is concerned, it might reduce the capacity for holding nutrients. This would lead to a serious decline in fertility and be yet another example of the danger of interfering with natural conditions without due consideration of all the possible consequences.

PRESENT ACTIVITIES IN THE LOW-COUNTRY

T. E. Walter

The organisation of the Institute's activities in the low-country has not altered since 1951. The staff consists of :—

(1) A scientific officer, (Mr. T. E. Walter), stationed at Pembroke, who is in charge of advisory and experimental work in the low-country.

(2) An assistant, (Mr. F. P. Jayawardene), who has been provided with an allowance in lieu of quarters.

In addition, Messrs. James Finlay & Company have very kindly made the services of Mr. C. Shanmugam available, for the supervision of the experiments on Galbode Estate.

Before discussing the field experiments, some further comment is necessary on the activities of the staff. In the first place, regarding the advisory work, it is evident that full advantage is not being taken of the facilities provided ; it must be pointed out, however, that the onus for making more use of these facilities obviously lies with the low-country planters themselves, in whose interests the service was made available. I would also take this opportunity of again drawing the attention of low-country planters to the fact that all low-country advisory correspondence should be addressed direct to the Scientific Officer, T.R.I., Pembroke, P.O. Bombuwela, nr. Kalutara.

The field experiments are carried out in liaison with the specialist officers, in whose particular province each experiment comes, and who are responsible for their design ; responsibility for their layout and upkeep devolves on the low-country scientific officer. It is necessary to point out here that a field experiment, which requires accurate recording of data by means of dry weights, occupies at least 2 days every week of an assistant's time, and hence the number of field experiments which it is possible to undertake is very severely limited by the assistant staff available. It must also be clearly pointed out that, (perhaps fortunately !) no single estate exists on which all the problems peculiar to the low-country can be investigated; it is obvious, therefore, that these problems have to be tackled, (by means of field experiments), on the estate in which each one is most prominent ; accordingly it has not been possible to centralise our activities with regard to these investigations.

The following is a summary of the experimental work now in hand :—

(1) A preliminary N.P.K. experiment on Vogan Estate.
(2) A pruning cycle experiment (on which is superimposed a Rhizoctonia control experiment) on Ingiriya Estate.
(3) Vegetative Propagation. Clonal trials with materials selected by low country estates are in progress on Vogan Estate, where 2 blocks of land, (4 acres and 6 acres respectively), have been leased for the purpose. Nursery sites are also available for our use.
(4) A Rhizoctonia control experiment on Galbode Estate.
(5) Shot-hole borer experiments on Galbode Estate.
(6) Shade experiments.

In addition to the above field experiments, the Director is extending his soil survey to low-country districts, with particular reference to the organic matter and nitrogen content at various depths.

An attempt has also been made by the writer to survey the progress made with regard to vegetative propagation on low-country estates.

The present position regarding each of the field experiments, together with their aims and objects, will now be discussed.

(1) N.P.K. Experiment (Vogan Estate).—A preliminary N.P.K. experiment of simple design is now in its second cycle. Previous yield levels of the field in question were just over 500 lb. per acre and the field is in general fairly typical of large areas of low-country tea. Two levels of each of the three main nutrient elements were laid down as a basis for the various combinations—namely, 39 and 78 lb. nitrogen, 18 and 36 lb. phosphoric acid and 24 and 48 lb. potash.

Results to date indicate that increased fertiliser applications do not give a corresponding increase in yields where the yield level is low to start with. This indication is amply supported by evidence obtained on other low-country estates. Following on from this trial, a further more complex experiment has been planned and will shortly be started on another estate, where a flattish area of uniform soil under an even stand of bushes provides the essential requirements for the work.

(2) Pruning Cycle Cum Rhizoctonia Control Experiment. Ingiriya Estate.—The object of this experiment is to determine the optimum engih of pruning cycle :—

(*a*) under normal low-country conditions, and

(*b*) when limitations due to diseases such as Rhizoctonia are eliminated by application of suitable control measures.

Apart from the obvious desirability of increasing yields by running as long a cycle as possible, this question is also linked with that of shot-hole borer control.

Cycle lengths of 1½ years, 2 years, 2½ years and 3 years are laid down for the various plots, and control measures thought to be effective against Rhizoctonia are superimposed on half the plots ; these measures consisted in spraying with Bordeaux mixture shortly after the plots were originally pruned, and again recently when disease symptoms began to appear.

The experiment has been in progress for 2 years and obviously at this stage no conclusive results can be recorded ; my latest observations, however, are as follows :—

(1) Die-back of the young shoots, accompanied by considerable leaf-fall, was evident on all the unpruned plots in May of this year, when heavy and continuous rain was experienced throughout the month.

(2) Yields have not as yet been affected by the die-back. The yields of all the unpruned plots are almost identical.

(3) The control measures referred to (spraying with Bordeaux mixture) have not had any effect on the disease symptoms described.

The inference from this is either that the disease is not in fact Rhizoctonia, or if it is, that Bordeaux mixture is not effective in controlling it. The first supposition is supported by the fact that Rhizoctonia has not been found in any of the isolations attempted by the Mycologist. On the other hand, careful examination of the infected material has so far shown the presence of the following :—

(*a*) White thread blight
(*b*) Red rust (*Cephaleuros parasiticus* Karst).
(*c*) Horse hair blight. (*Marasmius equicrinis*).

Further experiments are, therefore, indicated to show which, if any, of these is in fact the causal organism, and the Mycologist is pursuing this question by means of small scale infection trials on nursery plants.

(3) Vegetative Propagation (Vogan Estate).—Planting up of the 4 acre block has now been virtually completed and this year 4,500 plants were put out representing 30 of the best clones in our collection.

It was laid down originally that this 4 acre block should be used purely as a multiplication plot, from which cuttings of the most promising clones would be taken for further trials. No yield records are, therefore, available from this area, but a comparative assessment has recently been made of about 150 of the 200 old clones represented—based on their general vigour of growth and branching characteristics. In these observations the term ' outstanding ' was applied to 27 of the clones, while about 14 others were considered to be ' very good ', and certainly worthy of further trial ; about 66 of the clones showed only moderate or poor growth, which fact merely serves to emphasise the need for careful selection of mother bushes followed by small scale trials before large scale planting is attempted.

A feature of this area is the enormous variation in growth between the various clones. This is not surprising in view of the great difference in the degree of selectivity which had been applied previously on the estates from which they came. Thus 72 of the clones are from an original field selection of apparently outstanding mother bushes—of which about 5 turned out to be comparable to others listed as ' outstanding ' and about 10 ' very good '. On the other hand 17 of the clones (from 3 estates) represent the final product of a process of selection, which has been in progress on these estates since as long ago as 1938, involving trials with some 1,500 clones. Obviously, therefore, there is some first-class material in the collection and, though yield figures in respect of individual clones are not available as far as is known, one estate reports that a yield of 2300 lb. per acre has been obtained in the 3rd year of plucking from an area containing 3 of the clones referred to as ' outstanding '. This figure is based on the yield from 615 bushes, and is calculated for a stand of 5,000 bushes per acre.

It will be readily seen from this that no ' final ' stage has been reached with these clonal trials, and further trials with the best available material, (which has now been selected), are necessary before their use on a large scale can be recommended ; it should also be pointed out that the present clones were supplied to us on condition that they would not be made available for general distribution, without the prior consent of the estates concerned.

In view of the importance of V.P. work to low-country estates in their future replanting programmes, there is an obvious case for a considerable expansion of our activities in this direction. For this purpose a further clonal trial area—preferably in a district where the soil and climatic conditons are somewhat more favourable for V.P. work—is essential. It should also be borne in mind that experience has shown that clones do not necessarily reproduce the form shown in their own evironment when grown in a locality with a different climate. The latest developments in nursery irrigation technique also need to be tested under low-country conditions, for which purpose an area with a good supply of running water will be essential.

Nursery work is of course, proceeding, and at the moment there are some 18,500 cuttings in the nurseries from 36 clones. Small scale trials with a new type of nursery shading, using a ' pandal ' of open weave coir matting, have been highly successful ; at the moment it appears that 1/4 inch mesh weave is the most satsifactory for low-country conditions, (at least in the early stages), but further trials with other meshes are necessary before this particular gauge can be finally recommended.

(4) Rhizoctonia Control Experiment. (Galbode Estate). This experiment was laid down in an area where the symptoms of die-back and leaf-fall, (previously attributed to Rhizoctonia), are prevalent. These disease symptoms are particularly evident towards the end of the second year of the pruning cycle, and limit the length of the cycle which it is feasible to run to 2 years.

The experimental plots are, therefore, designed to run for 3 years, and the following treatments are being given :—

(1) Spraying with Perenox every 3 months.
(2) Spraying with Bordeaux mixture every 3 months.
(3) Thatching of the soil with Guatemala grass, or paddy straw, every 3 months.
(4) Weekly removal of diseased leaves.
(5) Control.
(6) High tipping (10').

This experiment has now run for 2 years, and again no conclusive results can be given ; sufficient evidence is, however, available from yield records and disease incidence to be able to report the following :—

(*a*) There is a close correlation between yields and disease incidence.
(*b*) Disease incidence is considerably less in treatments (3) and (4) (thatching and weekly removal of diseased leaves).
(*c*) Other treatments show no effect.

(5) Shot-Hole Borer Experiments (Galbode Estate).—The experiments now in progress were planned as a result of a series of preliminary observations and experiments made by Mr. Austin during a stay of 6 months on Hapugastenne Estate in 1952, when comparative trials were carried out with a number of insecticides on Galbode Estate. The present experiments are designed to give accurate information as to the degree of control that can be achieved in new clearings by spraying with the most promising insecticide, yet tried, viz: Dieldrex.

These experiments were laid down in a 1949 50 new clearing, and have now been in progress for a year. The treatments given, and the results achieved so far, are as follows :—

(*a*) A loss of crop experiment in which the plots are sprayed with Dieldrex at intervals of 10 days to eliminate shot-hole borer.

The latest examination, (the 8th), carried out just before the plots were pruned in August of this year, revealed the presence of only one affected branch with 2 galleries in the 25 bushes examined in the sprayed plots ; in the control plots (unsprayed) there were 20 affected branches with 61 galleries in 25 bushes.

(*b*) Another experiment in the same clearing is designed to determine the amount of control which can be achieved by spraying with Dieldrex at intervals of 6 weeks, 12 weeks and 18 weeks. Each of these areas is one acre in extent.

A recent examination of 40 bushes in each plot revealed the following :—

(i) Sprayed at 6 weeks interval : incidence of borer nil.
(ii) „ „ 12 „ „ : 1 branch affected, containing 1 gallery.
(iii) „ „ 18 „ „ : 60 branches, in 28 bushes affected, containing 121 galleries.

These experiments are continuing and provision has been made for periodical dissections as necessary.

In addition a number of detailed dissections have been made in a 1947/48 new clearing to show the association between shot-hole borer and die-back.

(6) Shade Experiments (Galbode Estate).—The object of these experiments is to investigate the effects of *Albizzia moluccana* as a shade tree in the high rainfall districts of the low-country, where its extremely rapid growth causes apprehension that it may be having an adverse effect on yields. Its effects, under varying rotations, will be compared with Grevillea.

These experiments were started in 1953, and the layout which has now been completed is as follows :—

(1) A 20 acre field of tea in bearing was divided into two halves and the yields of each recorded. A process of gradual elimination of the albizzias was later put in hand over the whole area ; on one half the albizzias were replaced with grevilleas, and on the other half albizzias were replanted. Yield records of the 2 areas are, of course, continuing and, by the time the albizzias are fully grown, a preliminary comparison can be made.

(2) A new clearing of 10 acres was chosen and divided into four approximately equal plots. Gliricidias had been planted in alternate lines on all the plots, and the shade tree layout in the intervening lines was modified as follows :—

(*a*) Grevilleas only.
(*b*) Albizzias + Grevilleas (in the same lines at double normal density).

The albizzias will be cut out after 4 years, (by which time the grevilleas will be sufficiently well grown to ' take over ').

(*c*) Albizzias only on a 6 year rotation.
(*d*) „ „ „ 8 „ „

PRESSURE REGULATION OF KNAPSACK SPRAYERS

J. Landreth

In the *Tea Quarterly* Vol. XXIII, Part III of 1952, the writer made a note on an improvement to pneumatic knapsack sprayers, namely regulation of the outlet pressures. Since that time several manufacturers of spraying machinery have incorporated pressure regulating devices as a normal fitting on their knapsack sprayers. It might be mentioned also that the attachment of such fittings is recommended by the World Health Organization. Although pressure regulating valves are by no means new and have been used for many years for accurate reduction in the pressure of compressed air, gas, liquid and steam etc., I think we can claim to be the first to have adapted these to suit knapsack sprayers. In low volume knapsack spraying constant output pressures are most desirable, especially as the spray characteristics of a given nozzle alter with any variation in the pressure.

Fig. 1 shows a section drawing of an efficient pressure regulating valve very similar to that fitted on the ' Favori-Colibri ' equipment, and the principle of its operation is as follows :—

Assuming liquid to be in the inlet side, Fig. 2 shows the valve held in the closed position by spring B. It will be noted also that the valve spindle is clear of the elastic diaphragm.

In Fig. 3 pressure has been applied to the diaphragm by altering the position of the handwheel which compresses spring A and in turn opens the valve and allows liquid to flow into the outlet side and thence to the spray nozzle. On liquid passing through the valve, the pressure gradually increases on the outlet side, compressing spring A through the diaphragm until the reduced pressure to which the valve is adjusted is reached, when the valve closes. As soon as the pressure on the outlet or reduced side begins to drop, spring A begins to open the valve again and the same cycle of operations takes place. Although a valve of the type shown in Fig. 1 can be adjusted to suit any pressure desired within the operating limits of a knapsack, there is no point in adjusting it to a higher pressure than the initial charge of air in the knapsack, as it becomes inoperative at any pressure lower than that to which it is adjusted.

Owing to the drop in pressure in a knapsack as the liquid discharges, regulation of outlet pressure within reasonable limits can only be obtained if the diaphragm in the reducing valve is of adequate area.

This type of valve has proved highly satisfactory and can be substituted for the normal outlet cock on a knapsack sprayer, the liquid supply being cut-off when desired by rotating the handwheel in an anti-clockwise direction. The two nuts fitted to the handwheel spindle are locked in position to give the desired pressure at the nozzle, after which no further adjustment is necessary.

A ' Favori-Colibri ' knapsack charged with air to 40 lb. per sq. inch and then with liquid up to 115 lb. per sq. inch (approximately $2\frac{1}{2}$ gallons) and fitted with No. OC-02 Boomjet Nozzles discharges in 6 minutes. When fitted with the Cooper Pegler Pressure Regulating Valve adjusted to give a nozzle pressure of 40 lb. per sq. inch, the time taken to discharge the knapsack is approximately 8 minutes. In other words the nozzle output with the regulating valve is $18\frac{3}{4}$ gallons per hour and without 25 gallons per hour. It is obvious from the foregoing figures that the additional cost of regulators is fully justified.

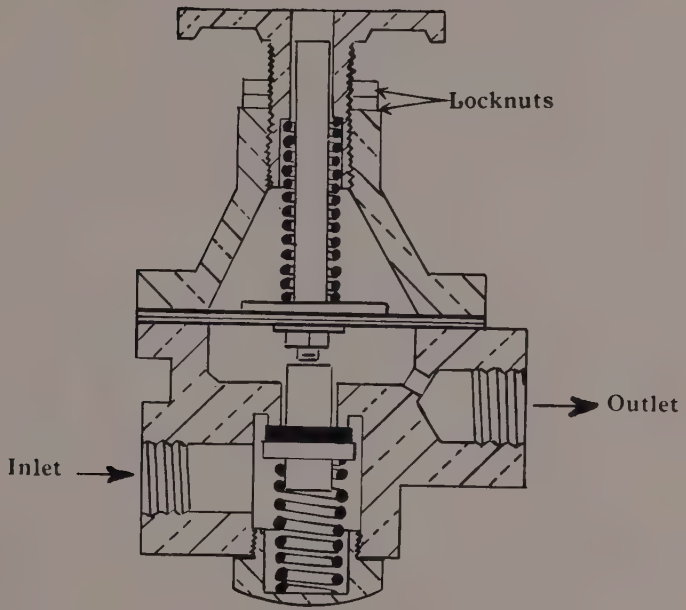

Fig. 1
Section Through
Pressure Regulating Valve

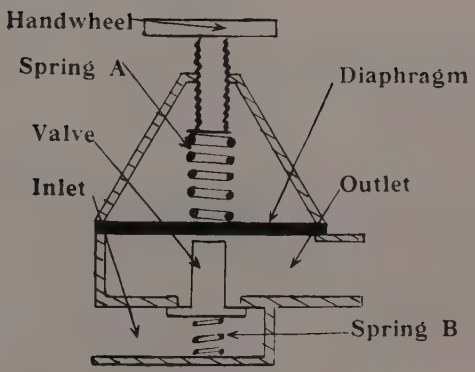

Fig. 2

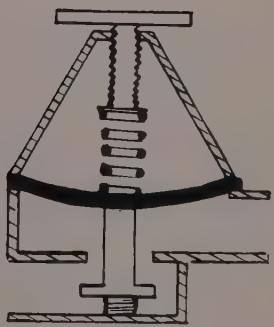

Fig. 3

A TALK GIVEN TO THE MORAWAK KORALE PLANTERS' ASSOCIATION ON 31st JULY, 1954

J. Lamb

In my talk on manuring at the last Conference I compared manuring to the process of paying into a current account at the bank. I made the point that payments into the account should be deposited at regular intervals and that they should be sufficient in amount to cover the maximum probable withdrawals.

During periods of vigorous growth i.e. rushes of crop, the available nutrients must be present in sufficient amounts to allow the bushes to make the most of the favourable periods of growth. There is no certainty that the soil bank will allow an overdraft.

It must be realised that manuring does not force crop. It only allows the bush to continue growing at the maximum possible rate when sunshine, warmth and moisture conditions are forcing. Growth must be active before nutrients can be taken up from the soil—the egg comes before the chicken. You can only *limit* the crop—by withholding nutrients, or by over-plucking ; that is to say, by removing too many leaves which are the lungs of the plant. Ninety per cent. of the crop is manufactured from carbon dioxide and water and no amount of manuring can compensate for over-plucking.

Another fallacy of which I must dispose is that phosphate makes root, potash wood and nitrogen leaf, and that you can increase wood or root growth by changing manurial mixtures. This is nonsense : you can only *upset* growth by supplying unbalanced manures.

The purpose of manuring is, therefore, simple and clear, and is to ensure that there is always enough nitrogen, phosphate, potash and other minor and trace elements to support the demand when growth is most rapid. There must always be a healthy balance in the nutrient bank.

So far I have done little more than summarise my remarks at the Conference. Today I propose to say more about the banking system for nutrients. Sulphate of ammonia and potash do not merely lie in the soil until they are wanted, nor do they wash out with the first shower of rain. Soil is far more complicated than a mere mixture of mineral particles of various sizes. It is to all intents and purposes a living thing—it breathes, feeds, excretes and one might almost say reproduces.

Clay and organic matter both possess a property known as base exchange capacity. As soon as highly soluble salts such as sulphate of ammonia and potash are dissolved by rain or soil moisture and come into contact with particles of clay and organic matter, the ammonia and potash are firmly held and the sulphate and muriate (chloride) pass on in the drainage water. The capacity for holding ammonia, potash, magnesium, lime, etc. is a characteristic of a soil and can be measured.

Once these nutrients have come through the base exchange process they are very resistant to leaching but are available to the plant when required. There is, therefore, no need to worry unduly about loss of manure by leaching even in a district where rainfall is heavy. The phosphate in saphosphosphate is of course insoluble in water. It is slowly dissolved by the soil acids and possibly by acids excreted by plant roots. The phosphate dissolved by the soil is held by the clay to some extent, probably in association with iron and aluminium, but I don't want to become too technical. I can assure you that if you supply the nutrients the soil is well able to look after them so long as it is in good condition. It is important, however, that there should be at least light rain after manuring and that the manure should be scuffled in so that the nutrients get down below the surface subject to alternate wetting and drying. The stored potash and phosphate are liable to undergo changes which spoil their nutrient value if the soil is dried out.

The phosphate and potash stored in the soil are ready for use when required by the plant, but the ammonia has to undergo further changes. Recent work at the Tea Research Institute indicates that tea cannot use ammonium ions directly in the way some plants, for instance paddy, can. Ammonium ions held by the clay and organic matter have to be oxidised by bacteria first to nitrite and then almost immediately to nitrate. Nitrate is not held by the soil and washes out very easily, and this is why we recommend the application of nitrogen in the form of sulphate of ammonia rather than as nitrate.

It is important, therefore, that the stores of ammonium ions should be adequate so that a steady supply of nitrate is made available by bacterial action. It is probable that the rate of nitrification is highest when the stocks of ammonium ions are high. This is the case in most soils, and we expect it will prove to be the case in tea soils. We are at present engaged in studies of the rate of nitrification. At the high soil temperatures usual in the low-country the rate of nitrification appears to be plenty high enough, but in some up-country areas, where the soil temperatures are much lower, there are some indications that the rate of nitrification may be too slow. We are, in fact, exploring possible means for increasing the rate of nitrification where it is very low.

Apart from warmth, nitrifying bacteria require a good supply of calcium, phosphates and proper balance of the trace elements iron, copper and zinc. There is an abundance of iron and manganese in all our soils. We have also investigated the copper and zinc status of Ceylon soils and it appears to be adequate. In fact we are indebted to Mr. Fernando for carrying out some experiments with zinc sprays on Enselwatte Estate. The calcium status of our Ceylon soils is, however, low and the calcium phosphate of saphosphosphate is, for this reason, undoubtedly an important constituent of TRI-500. It is, therefore, necessary, when formulating a manure mixture, to take into account factors other than the simple requirements of nitrogen, phosphate and potash, for they are by no means the only minerals which may be needed by the plant or the soil. Recent analyses of leaf from our manurial experiments indicate that tea has a marked requirement for calcium. Although tea will not grow in calcareous soils, (soils rich in lime), the element is undoubtedly essential for growth. Tea leaf contains as much, sometimes more, calcium than phosphate, and the composition of the minerals in the leaf, from plots receiving a wide range of different manurial treatments, reflects the amount of calcium added as calcium phosphate. Calcium and magnesium requirements are closely linked with potash requirements and may to a limited extent act as substitutes for potash or, perhaps it would be better to say, as potash economisers.

One of the difficulties of research on the mineral needs of plants is that they may take up more of the easily available minerals then they need. Unlike animals, plants lack the power of excretion and may accumulate considerable quantities of minerals in their tissues. The total amount of any particular mineral is, therefore, not necessarily a measure of its importance. Generally speaking, plants require

comparatively large amounts of nitrogen, phosphate, potash, calcium, magnesium, iron, manganese, aluminium, sulphur and other similar elements. The general practice is to refer to these elements apart from nitrogen, phosphate and potash (abbreviated NPK) as minor elements. The most minute quantities of other elements such as boron and molybdenum may, however, be equally essential, and growth will fail without them. As a parallel illustration I give the example of the amount of platinum in your car. It is very small by comparison of the amount of iron, aluminium, (and perhaps chromium in the form of plating), but unless there is sufficient platinum on the contact breakers and plug points, the car will not work. Such elements are generally referred to as trace elements, and include copper and zinc, which are present in Ceylon tea in unusually large amounts compared to other plants. Copper is known to be essential for proper fermentation of tea.

Saphosphosphate and muriate of potash recommended in TRI-500 are quite important sources of minor and trace elements. Saphosphosphate, for example, contains 48 per cent. of lime, 0.85 per cent. of magnesium, 0.2 per cent of zinc and 0.013 per cent. of copper. Muriate of potash contains up to 0.8 per cent. of magnesium. Both saphosphosphate and muriate of potash contain a wide variety of trace elements. So far as we are aware, therefore, TRI-500 contains all the mineral nutrients required by tea. The proportions of nitrogen, phosphate and potash, and the amounts recommended for application at different crop levels are based on 25 years' of field experiments. It is possible that in future we may recommend variations for different districts and elevations, but at the present moment TRI-500 is the best informed guess we can make at the correct mixture for tea, and I frankly doubt whether anyone, who has not studied the subject in such great detail as we have at the Tea Research Institute, can do any better.

MISCELLANEOUS NOTES

A MINIATURE ROLLER FOR CLONAL EXPERIMENTS

J. Landreth

A miniature roller was recently constructed here for clonal experiments, taking a charge of 1 pound of withered leaf. The machine is a 1/6 scaled down version of a full size single action roller. The pressure pad has been modified to take a piece of perspex sheet in order that circulation of the leaf may be observed. M & S satinwood battens, continued into a brass cone, are fitted to the table. Pressure is applied directly to the pressure screw through a spring loaded nut fitted with three arms. Power required under full pressure is 1/3 H.P.

The machine is driven by a 1/3 H.P. electric motor running at 1,750 r.p.m. direct coupled to a worm reduction gear of 26 to 1 and fitted with a clutch. A further reduction of 2 to 1 is made through a set of bevel gears fitted in the roller driving pedestal, giving a jacket speed of approximately 34 r.p.m. The gearing runs in totally enclosed oil-baths. Ball bearings are fitted to the cranks and phospor bronze brushes to the jacket frame. No castings were used in the construction of the machine, all parts being suitably formed, welded and machined in mild steel and brass. The complete assembly is mounted on a steel panel.

An illustration of the roller appears in Photograph 1 and Photograph 2 gives a close-up view of the rolling table.

A NOTE ON THE OPERATION OF THE MINIATURE ROLLER

E. L. Keegel

For a roller of this size to give the best results two important considerations have to be borne in mind. One is that the type of central fittings and battens should not be so severe as to cut up the leaf unduly. The other is the duration of rolling, which should be much longer than the standard generally accepted in commercial practice.

The reason for these precautions is that, owing to the very small amount of leaf handled, hardly any heat is developed in the process of rolling. In consequence fermentation is considerably reduced. If too much dhool is, therefore, extracted in the early stages, or the period of rolling shortened, a greenish brew is sure to result. The aim should be to keep the leaf as long as possible in the machine with the pressure cap down all the time.

The ' perspex ' panel in the pressure cap is an essential part of this roller for it enables the circulation of the leaf to be observed and the amount of pressure to be applied. By careful adjustment of pressure it should be possible on a roller of this size to do four rolls and get orthodox dhool outturns as well. No difficulty was experienced in obtaining these results when working with an initial charge of 1 pound of withered leaf. Typical percentage dhool outturns were 19, 20, 35, 25 and B.B. 10. The minimum charge of rolled leaf for satisfactory rolling appeared to be 5-6 ounces.

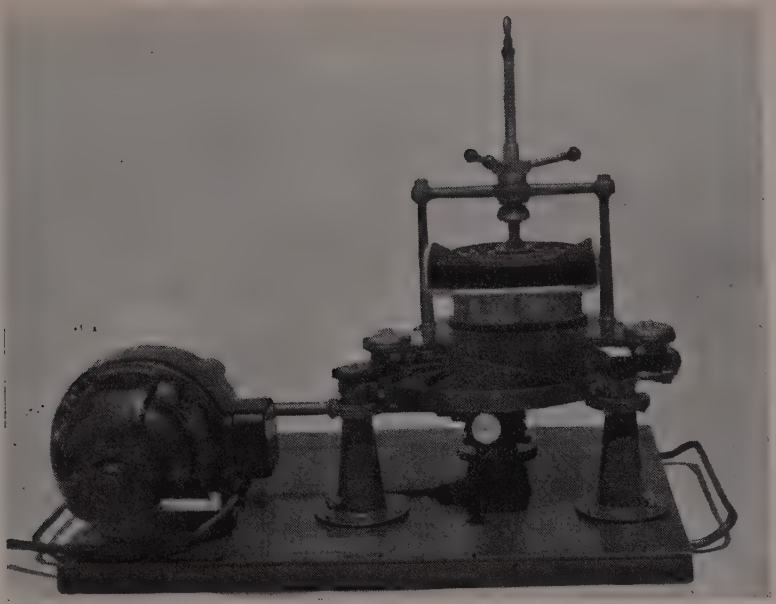

Photo by J. Landreth.

Photograph 1. The miniature roller, which was recently constructed by the Engineering Department.

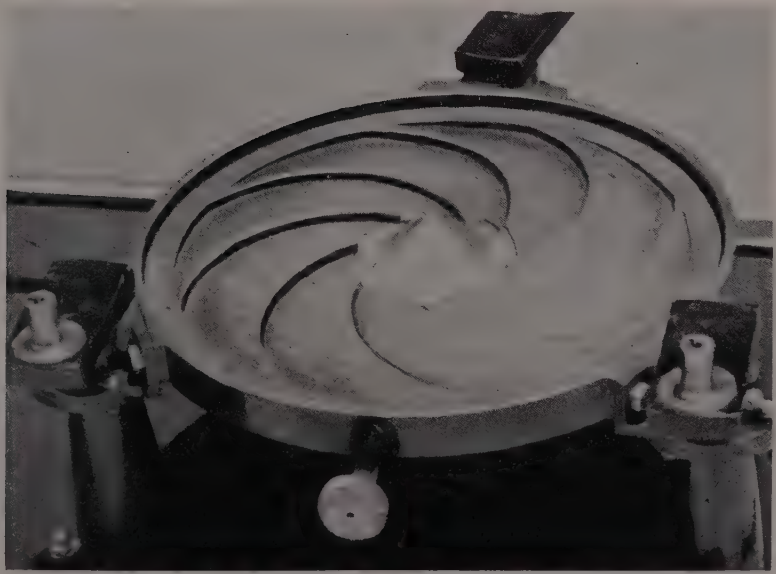

Photo by J. Landreth.

Photograph 2. View of the rolling table of the miniature roller.

From the results obtained so far the following method is recommended for the manufacture of clonal leaf :—

Wither.—Medium—a hard or soft wither is not suitable.

Rolling.—4 × 45 minute rolls.

Green leaf sifting.—Dhools to be taken through 3 mm. stamped aluminium or No. 6 mesh. A hand sieve, about 16 inch diameter and 1 inch in depth is a convenient size.

Fermentation.—4 to 4½ hours. If the period is too short liquors are apt to be harsh.

Grading.—The use of No. 10, 18 and 30 mesh will give the usual outturns of B.O.P. and Fannings grades.

The criticism that normal teas cannot be made on such a diminutive scale can no longer be maintained. The liquors, though slightly lighter and greener, are similar to commercial style teas and the appearance is up to normal commercial standard.

NOTES ON SOME INSECT PESTS

G. D. Austin

A few species of insects, hitherto considered of minor importance, were reported during the year 1953 when they temporarily assumed the status of pests. They caused sufficient concern to justify their being mentioned for purposes of record.

(1) *Toxoptera aurantii* Boyer. (Aphididae) Tea Aphis.—Tea aphids are small, soft-bodied, blackish insects, invariably confined to the tender shoots of tea seedlings, young clonal plants, and tea recovering from pruning. Following their feeding i.e. sucking the sap, shoots become curled and stunted. They are sensitive to weather conditions : are preyed upon by many natural enemies which include ladybird beetles and larvae, lace-wing flies, Syrphid larvae, the hymenopterons *Aphidius* sp. (Braconidae), *Eurytoma* sp. (Eurytomidae), and a parasitic fungus *Empusa* sp.

During the long spells of dry weather in Uva the bugs become a nuisance, especially in nurseries, where they cause a definite set-back to the growth of V.P. cuttings and seedlings. If natural enemies fail to cope with the situation,the remedy lies in spraying the nurseries with a nicotine spray.

(2) *Melanagromyza theae* Cotes (Agromyzidae) Tea leaf-miner.—The mines caused by the larvae of this minute blackish fly, which is rather similar to the common ' eye fly ' in appearance, continue to be mistaken for early stages of blister blight attack. The fly oviposits on the upper surface of the tea leaf and the larvae or maggots, on hatching, tunnel their way under the epidermis producing a blotched or blister-like appearance—hence the confusion with the fungus ' blister blight '. Observations at Passara indicate that weekly spraying with Perenox (for protecton against blister blight) did not prevent the fly ovipositing on the tender foliage of young tea plants.

Though the effect of the mines on a mature tea bush is insignificant, the presence of several blotches on the foliage of young tea plants when quite a considerable area of the leaves are mined, has a decided effect in retarding growth of the young plants. A gammexane or D.D.T. spray should control the fly on young tea. This miner was for many years known as *Oscinis theae* Bigot. Vide *T.R.I. Bull.* No. 22, p. 49.

(3) *Simplicia robustalis* Guen. (Noctuidae). After a lapse of half a century, according to recorded observations, the brownish caterpillars of the Noctuid moth appeared in very large numbers in the Ratnapura district where they caused considerable defoliation of tea recovering from pruning, especially in new clearings. Hand collecting the caterpillars was found to be extremely difficult. A 50 per cent. D.D.T. spray at a concentration of one pound to 30 to 40 gallons water was very satisfactory.

Regarding this species, Green (Ceylon's first Government Entomologist) wrote as follows in his report for 1903 ' The small brown caterpillars of this moth have been reported on several occasions as infesting tea prunings on recently pruned fields. As long as they confine their attention to the prunings no harm will be done ; but after breeding in the withered prunings they have commenced to devour the living tea '. No local parasites have so far been recorded from this caterpillar which is known to feed on tea only.

(4) *Porthesia* (*Euproctis*) *scintillans* Wlk. (Lymantriidae). This is a hairy, dark-coloured, caterpillar with yellow stripes down its back, adult moths being yellowish in colour. It is met wherever tea is grown. The young caterpillars on hatching are gregarious in habit and skeletonize the leaves as they feed ; as they grow older they migrate and confine their depredation to mature foliage.

A peculiar feature of the caterpillar in recent years is its predilection to feed on the mature blisters of *Exobasidium vexans* which it completely devours, leaving a circular hole indicating the size of the blister consumed.

The caterpillar might have been worth encouraging for the biological control of blister blight had it confined its taste to blistered tea only. As records stand, however, it is known to feed on at least ten host plants in addition to tea. It has one larval parasite—a species of *Apanteles*.

(5) *Indarbela* (*Arbela*) *quadrinotata* Walk. (Cossidae) Bark-eating borer.—Beyond reports by Green in 1903 and S. Stuart Light in 1927, the writer has so far not seen or come across any records of this bark feeding caterpillar paying any attention to tea in Ceylon. It is a moot point whether the caterpillar ever does any serious damage to Albizzia on which host it is frequently seen wherever tea is grown.

Even Green wrote ' it feeds upon the superficial layers of the bark and does not appear to cause much real injury here though in India it is regarded as a serious pest of tea '.

Its run-ways or galleries which are covered with frass, and under which it feeds and moves, are certainly unsightly and perhaps alarming to see in a tea field.

Strong applications of Gammexane P. 520, D.D.T. 50 per cent. and Dieldrin failed to have any effect on the caterpillars when sprayed on *Albizzia falcata* in the Balangoda district.

Hainsworth, author of ' Tea Pests and Diseases and their Control ' must have obtained satisfactory results in India becuase he recommends 1 lb. of 50 per cent. D.D.T. powder in 40 gallons water as giving excellent control.

(6) *Actias selene* Hb. (Saturniidae). The Moon moth.—An opportunity of testing the authenticity of an old record that tea is one of the host plants of the beautiful Moon Moth, *A. selene*, presented itself when a small collection of a week old caterpillars was received at the Passara laboratory towards the end of the year. On arrival the caterpillars were at once offered the foliage of both tea and the Patna Oak (*Careya arborea*) which they fed on quite readily. The caterpillars were then fed solely on tea and the following life-history data recorded :—

Photo by J. Landreth.

Photograph 3. Ferguson trailer modified for leaf transport.

Photo by J. Landreth.

Photograph 4. The new glass-house, St. Coombs.

Incubation period	...	13 days
Larval period	...	48 to 63 days
Pupal period	...	36 to 53 days
Egg to adult	...	97 to 129 days

The adult *A. selene*, with its wings of a pale, sea-green and the hind wings tapering into long curved tails, is one of our most beautiful moths. The larvae, though allied to the silkworms of commerce are not of economic importance. Besides the two host plants already mentioned, caterpillars are known to feed on *Odina wodier* Roxb. ' Hik ', and *Eugenia jambolana*. Lam.

AMERICAN BOOMJET NOZZLE OC-02

J. Landreth

This nozzle was first imported into Ceylon by us in February, 1952, and some figures on its performance may be of interest.

With the tips correctly adjusted, at a working pressure of 40 lb. per sq. inch coverage to a width of 11′ 8″ is obtained if the nozzle is held 30″ above the crop. By moving the lance from side to side when proceeding through the rows four rows of bushes can in most cases be effectively covered in old tea. In the new tea fields on St. Coombs Estate two rows are sprayed simultaneously. Assessing the protection given, there is every indication that it is comparable to that given by any other make or type of nozzle previously tested here.

The original Boomjet Nozzle tips are still in use after 2½ seasons spraying which is largely due to the fact that efficient filtering takes place on our charging equipment ; consequently frequent cleaning of the nozzle orifices is not necessary.

The task on St. Coombs is 4 acres per labourer per working day of 6 hours on the old fields and 3 acres in the new fields, using the power charging equipment described in the *Tea Quarterly* Vol. XXV, Part I of 1954.

A NOTE ON LEAF TRANSPORT

J. Landreth

All green leaf on St. Coombs estate is transported in baskets. Our 3 ton ' Ferguson' trailer body has been suitably modified to accommodate 3 tiers of baskets 24″ × 24″ × 17″ deep. Forty-five baskets, each containing 50 lb. of leaf, can be carried inside the trailer, but when required a further 10 baskets are carried on the tailboard. The accompanying illustration (Photograph 3) shows the modified trailer carrying a load of baskets.

As the modifications to the trailer are of a permanent nature, the vehicle had to be re-registered in compliance with the Motor Traffic Act, No. 14 of 1951.

ESTATE GREENHOUSE

J. Landreth

In the *Tea Quarterly* Vol. XXIII, Part IV of 1952, there is an article by Dr. Haworth on the establishment of green manures, in which he mentions a greenhouse for this purpose.

A greenhouse, recently built here, is illustrated in Photograph 4. For those interested the specification is as follows :—

Size.—30′ 0″ × 18′ 0″, 6′ 0″ at eaves and 12′ 0″ at ridge.
The roof trusses are in 2″ × 2″ × $\frac{1}{4}$″ T iron, the purlins in 2″ × 2″ × $\frac{1}{4}$″ angle iron and the 1/8″ thick glass is set in $1\frac{1}{4}$″ × $1\frac{1}{4}$″ × $\frac{1}{4}$″ T iron which is attached to the purlins by countersunk headed screws. Aluminium clips and ' Stopstara ' putty are used to retain the glass in position.

A 3′ 0″ high dwarf wall surmounted with expanded metal with concrete pillars encloses the building, and a sliding door is fitted in the end wall. A suitable watering system manufactured by British Overhead Irrigation Limited, has been ordered and should arrive in the near future.

The all in cost of this building including irrigation is approximately Rs. 6,800/-.

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD AT THE OFFICES OF THE PLANTERS' ASSOCIATION OF CEYLON AT 2-30 P.M. ON FRIDAY, 21ST MAY, 1954.

Present:—Mr. R. C. Scott, C.B.E. (Chairman), Dr. A. W. R. Joachim, O.B.E. (Director of Agriculture), Messrs. T. E. D. Loftus, C.C.S. (Assistant Secretary Ministry of Finance, representing the Minister of Finance), Kenneth Morford C.B.E. (Chairman, Planter's Association of Ceylon), D. F. Ewen, C.B.E. (Chairman Agency Section, Planters' Association of Ceylon), D. C. L. Amarasinghe, C.C.S. (Tea Controller), W. Neal de Alwis, M.P., D. E. Hettiarachchi, J.P., U.M., Errol Jayawickreme, J.P., U.M., A. J. Dickson, A. D. McLeod, C. D. Green, H. S. Hurst and J. Lamb (Director and Secretary).

Mr. W. P. H. Dias, J.P., Chairman, Board of Management, Rubber Research Institute of Ceylon, Dr. H. E. Young, Director of the Rubber Research Institute, and Mr. E. S. Rose, Superintendent, St. Coombs Estate, were also present by invitation.

A letter regretting inability to be present was received from Mr. V. G. W. Ratnayake, M.B.E., M.P. A message from Sir Arthur Ranasinha intimating his inability to attend was conveyed by Mr. T. E. D. Loftus.

1. Notice convening the meeting was read.

2. **Minutes of the Meeting of the Board held on 19th February, 1954.**

The minutes were confirmed subject to the amendments notified to members in circular No. A7/54 of 12th May, 1954.

3. **Membership of the Board & Committees**

(a) Board.

The following changes in the personnel of the Board were reported.

(i) *Ex-officio Members.*

On his appointment as Chairman of the Agency Section of the Planters' Association of Ceylon as from 10th March, 1954, Mr. D. F. Ewen, C.B.E., had replaced Mr. C. D. Green.

Mr. Kenneth Morford, C.B.E., on his appointment as Chairman of the Planters' Association of Ceylon, had replaced Mr. W. R. Vander Kiste as from 27th March, 1954.

Mr. D. C. L. Amarasinghe who was appointed Tea Controller on 29th April, 1954, had replaced Mr. B. Mahadeva. The Chairman offered his and the Board's congratulations on his appointment.

(ii) *Representing the Planters' Association of Ceylon, Agency Section.*

Mr. C. D. Green had been nominated to succeed Mr. W. H. Attfield, who had resigned his seat on the Board with effect from 10th March, 1954. Mr. Green would be away from Ceylon for about a month from 31st of May.

Mr. A. D. McLeod, whose term of nomination had expired on 31st March, 1954, had been renominated.

(iii) *Representing the Low-Country Products Association.*

The period of nomination of Messrs. W. Neal de Alwis and Errol Jayawickreme had expired on 5th March, 1954.

Mr. Errol Jayawickreme informed the meeting that the Low-Country Products Association had nominated Messrs. J. L. D. Pieris and B. Amarasuriya as their representatives on the Board.

The Chairman thanked the outgoing members for the service they had rendered to the Institute as members of the Board. He welcomed the incoming members.

(b) Finance Sub-Committee.

(i) Mr. Kenneth Morford had replaced Mr. W. R. Vander Kiste as from 26th March, 1954.

(ii) Dr. A. W. R. Joachim had resigned as from 31st March, 1954. As the Committee concerned itself mainly with matters of finance it was proposed that the member representing the Minister of Finance on the Board should take his place. Agreed.

(c) Experimental and Estate Sub-Committee.

Mr. R. J. S. Bean had resumed his seat on the Experimental and Estate Sub-Committee on his return from leave out of Ceylon. He therefore replaced Mr. A. Watt who had acted for him.

(d) Small Holdings Sub-Committee.

At the meeting of the Small Holdings Sub-Committee held on 18th February, 1954, it was proposed that the Tea Controller should take the place of Dr. A. W. R. Joachim who had resigned his seat. Agreed.

(e) Standing Committee.

The Director commented on the usefulness of the Special Sub-Committee and the part it had played in the immediate past.

Mr. H. S. Hurst questioned the function of the Committee which, he considered, was set up for a special purpose. He thought the continuance of the committee would overlap the duties of the Finance Sub-Committee. He also objected to the name given to the committee.

The Director stated that the main function of the Finance Sub-Committee was the consideration of the Auditors' Report and the Estates and Research Estimates at the end of each year. It held at the most two meetings in the course of a year.

Mr. Green proposed and Mr. A. J. Dickson seconded that the committee should henceforward be called the Standing Committee of the Board. Approved.

Mr. Errol Jayawickreme said that he would no longer be a member of the committee. On the Chairman's proposal, Mr. D. E. Hettiarachchi was elected to fill the vacancy.

Mr. C. D. Green remarked that he was a member of the committee as Chairman of the Agency Section of the Planters' Association. He therefore suggested that Mr. D. F. Ewen should take his place. Agreed.

4. **Finance**

The Chairman reported that acting on the advice of Messrs. Forbes & Walker the following investments had been made :—

(i) Tea Research Institute of Ceylon Rs. 75,000 Stock in Ceylon Government 3½ per cent. National Loan 1964/69 at a cost of Rs. 73,088/50.

(ii) Tea Research Institute of Ceylon, Small Holdings Advisory Service Rs. 120,000 Stock in Ceylon Government 3½ per cent. Loan 1959/64 at a cost of Rs. 117,987/10.

(iii) Tea Research Institute of Ceylon Junior Staff Provident Fund Rs. 30,000 stock in Ceylon Government 3½ per cent. Loan 1959/64 at a cost of Rs. 29,497/52.

(iv) The repayment proceeds of the £6,750 2½ per cent National War Bonds, viz. Rs. 89,688/58, had been placed on Fixed Deposit for three months as from 21st April, 1954.

On the proposal of Mr. W. Neal de Alwis, seconded by Mr. Errol Jayawickreme, it was agreed that enquiries should be made as regards investing any available funds of the Institute in the Bank of Ceylon 4½ per cent. Housing Scheme Loan.

5. **Minutes of the 87th Meeting of the Experimental and Estate Sub-Committee held on 20th March, 1954**

The Chairman stated that copies of the minutes, together with the Visiting Agent's Report, which had been discussed at the meeting of the committee held on 20th March, 1954, had been issued to members.

Sanitation on St. Coombs including the T.R.I.

The Chairman referred to the Report issued by the Planter's Association Medical Officer, Dr. O. J. S. MacDonald, M.D., in which he had stressed the necessity for early action in respect of the recommendations contained therein. Estimates were being prepared and would be put up to the Board at the next meeting.

6. **St. Coombs Estate.**

Profit from St. Coombs Estate for 1953.

The Chairman said he was pleased to report that St. Coombs Estate had finished up the year 1953 with a profit of Rs. 113,764/57, the second highest recorded since 1929 when the estate became the property of the Institute. In 1947 the profit was Rs. 175,763/57.

Two or three sales ago St. Coombs had topped the Colombo Auction with Tientsin at Rs. 2/90.

The crop this year to the end April was 11,957 lb. more than last year.

7. **Staff**

(a) Engineer—Mr. J. Landreth.

The Chairman reported that Mr. Landreth had, by letter dated 21st April, 1954, tendered his resignation from the post of Engineer. The resignation had been accepted from the above date, which means that Mr. Landreth would leave the services of the Institute as from 21st October, 1954.

(b) Pathologist—Mr. C. A. Loos.

The Chairman stated that Mr. Loos, as members would recall, was awarded a grant under the F.A.O. Technical Scheme for a visit to the U.S.A. in 1952, but was compelled to postpone the visit on account of his wife's illness. Mr. Loos had recently been informed that should he not make use of this award now he would lose it.

Mr. Loos was due to leave Ceylon on 2nd June. Arrangements had been made for him to visit Dr. Kenneth Smith at the Molteno Virus Research Station at Cambridge, where work is being carried out, in co-operation with the Tea Research Institute, on virus disease of nettle grub. He is due to arrive in the U.S.A. by June 15th and would remain there for about six weeks.

(c) Agricultural Chemist—Mr. J. A. H. Tolhurst.

It was reported that Mr. Tolhurst had returned to Ceylon with his family on the 16th May, 1954.

(d) Technical Assistant to the Director—Mr. J. V. Harbord.

As decided at the last meeting the appointment had been offered to and accepted by Mr. Harbord. His employers, Universal Crop Protection Ltd., had agreed to release Mr. Harbord as from 1st June, 1954.

(e) Entomologist.

It was reported that an advertisement had been sent to the local press calling for applications for the post. Mr. Austin would remain in service until the post was filled.

(f) Technologist for Factory Research.

The Director said that he intended calling for applications for the post almost immediately.

It was agreed that the post should be advertised first in Ceylon, and that, should there be no suitable candidates, it be advertised in 'Nature' as a case would have to be made out to Governement for employment of a non-Ceylonese.

8. Any Other Business

(a) Arrangements for Out-Station Staff to be at St. Coombs for the Annual General Meeting of the Junior Staff Association.

It was reported that the Junior Staff Association had made the request that out-station members be allowed to make an annual visit to St. Coombs to coincide with the Annual General Meeting of the Association.

The Director stated that he had allowed the request for 1954 but should like to have the Board's authority for future dates.

It was agreed that the request be allowed on the understanding that the Association fixes its Annual General Meeting whenever possible on a date which would necessitate the visit of out-station members to the Institute, such as for a conference or demonstration.

(b) Conference.

It was agreed to hold the Institute's Biennial Conference next year.

J. LAMB,
Secretary.

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